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ORIGINAL STUDY

Muscle timing in injured and non-injured leg of athletes with chronic ankle instability in response to a visual stimulus during forward jumping

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KEYWORDS
Chronic ankle instability;
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Summary *Objective:* The aim of this study was to investigate premotor time, motor time and reaction time of the injured and non-injured leg muscles of athletes with chronic ankle instability in response to a visual stimulus during forward jumping.
Methods: Surface electromyography was performed on injured and non-injured leg of eight athletes with chronic ankle instability during forward jumping.
Results: Results showed that premotor time of the peroneus longus was significantly longer in non-injured leg compared with injured leg (489.37 ± 220.22 ms vs. 306.46 ± 142.92 ms, P = 0.031); on the contrary, motor time of the peroneus longus was significantly shorter in non-injured leg compared with injured leg (569.04 ± 318.62 ms vs. 715.12 ± 328.72 ms, P = 0.022). No significant

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difference was noted in the timing of other calf muscles ($P > 0.05$).
Conclusion: According to the results of this study, rehabilitation protocols, regarding ankle instability, need to put greater emphasis on tasks that require proper timing of muscles and muscle re-education so that protocols could reduce residual symptoms after sprain and prevent recurrent sprains.

Introduction

Lateral ankle sprains are one of the most common injuries of the human musculoskeletal system (van Rijn et al., 2011). The results of an epidemiologic review study dealing with sport injuries, revealed that ankle is the second region prone to injury in human skeleton and one of the major ankle injuries is ankle sprain which involves 80% or even 100% of ankle injuries (Fong et al., 2007). Ankle sprains due to sport injuries account for one-sixth of absences in sport competitions (Wright et al., 2000). A review study showed that 5%–33% of patients with ankle sprain having received common treatments continue to experience pain and instability. 34% of patients with ankle sprain reported at least one occurrence of recurrent sprain and 15%–64% reported that they have not recovered fully after one year of follow-up (van Rijn et al., 2011). It is also important to note that ligament injuries and instability of the lateral ankle are among the most common causes of post-traumatic osteoarthritis and joint damages; therefore, the prevention of chronic instability may be an important step toward preventing osteoarthritis (Brown et al., 2008). Prevention of ankle instability is possible only when pathologies are identified (de Noronha et al., 2006). Factors such as proprioception, range of motion, muscle strength, muscle reaction time, and postural sway deficits in neuromuscular system have been identified as sources of possible causes of instability in literature (Gribble et al., 2004; McKeon and Hertel, 2008; Beynnon et al., 2002); moreover, there is evidence that the evertor muscles timing may play a fundamental role in creating residual symptoms following inversion injuries. It seems that, there are other mechanisms underlying ankle sprain instability plus to articular deafferentation disorder (Delahunt, 2007).

As the literature indicates, various diseases may be associated with cognitive dysfunction. Studies have suggested that psychomotor dysfunction can accompany musculoskeletal disorders. The linkage between chronic low-back pain and slow reaction time has been proven. Psychomotor Reaction Time (RT) is the duration between the onset of an unexpected stimulus and a specific motor response to the stimulus. Reaction time can be tested with measurement devices such as simple RT (one stimulus) or choice RT (multiple stimuli). Choice RT includes decision time and movement time; Decision time or premotor time represents the amount of time needed for information processing in the central nervous system, and movement time or motor time is the interval from initiation of the response to completion of the movement (Luoto et al., 1999). Most studies having examined the reaction time of the calf muscles, used inversion perturbation with electromyographic (EMG) monitoring (Mitchell et al., 2008; Konradsen et al., 1997; Konradsen and Ravn, 1991; Benesch et al., 2000; Osborne et al., 2001; Myers et al., 2003; Lynch et al., 1996; Lofvenberg et al., 1995; Sheth et al., 1997; Vaes et al., 2001; Konradsen and Ravn, 1990; Karlsson and Andreasson, 1992; Ebig et al., 1997). It is also important to mention that, all previous studies recorded psychomotor reaction time by pressing buttons or pedals and reflex behaviors of the ankle muscles were not studied with regard to decision time or psychomotor RT detected in a non-functional test.

At the level of elite sports, where milliseconds can make the difference between the winner and the loser, even small changes in reaction time can lead to a dramatic impact; therefore, this study intends to compare the timing of calf muscles and reaction time in injured and non-injured leg of athletes with chronic ankle instability in response to a visual stimulus during a functional forward jump. This study also intends to investigate the performance of central motor programs as well as the peripheral performance, to reveal hidden aspects of chronic ankle instability.

Methods and material

Eight athletes with chronic ankle instability (2 female, 6 male, age $= 23.75 \pm 2.05$ year old) participated in this study. Participants were physical education students of Tehran University exercising regularly three times a week for at least 2 h in each time. Before initiation of the study, individuals completed an informed consent form. The initial assessment included the personal data questionnaire and measurements of weight and height. The study was also approved by Ethics Committee of Tehran University of Medical Sciences.

Inclusion criteria: (a) ages of participants ranged from 18 to 32 year old, (b) there should be no history of heart disease, cardiovascular disease, diabetes, visual disturbances, vestibular disorders, neurological disorders, dizziness, cognitive problems and musculoskeletal trauma in lower limb for any of the participants, (c) a history of ankle sprain in one foot (6 months–1 year needed have be passed since the initial injury and repeated ankle sprain needed to have occurred at least once during this period and participants also needed to feel 'giving way' in their ankles) and (d) no pain and restriction in both ankles during the test and negative talar test in non-injured leg.

Exclusion criteria: (a) athletes taking medications that affect cognitive and motor function or stimulating drinks

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